

## SECTION I.—AEROLOGY.

## SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1916.

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For a description of instrumental exposures and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, April, and May, 1916, 44:2, 179–180 and 244, respectively.

The monthly means and departures from normal values given in Table 1 show that direct solar radiation intensities averaged slightly below normal at Washington, D. C., and Lincoln, Nebr., and slightly above normal at Madison, Wis., and Santa Fe, N. Mex. At Lincoln, Nebr., a noon intensity of 1.56 calories on the 24th exceeds any noon intensity measured at that station during November, 1915.

Sky light polarization measurements made at Washington on 13 days, with the sun at zenith distance 60°, give a mean of 54 per cent and a maximum of 64 per cent on the 27th. This latter is 8 per cent less than the maximum obtained in November, 1914; but it is 6 per cent greater than the November maxima of 1903 and 1904. The monthly mean is 9 per cent less than the November mean for the two years 1914 and 1915.

TABLE 1.—Solar radiation intensities during November, 1916.

(Gram-calories per minute per square centimeter of normal surface.)

Washington, D. C.

Date.	Sun's zenith distance.										
	Air mass.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	
A. M.	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	
Nov. 1	1.36	1.19	1.08	0.94	0.83	0.77	0.71	0.66	0.62		
2	1.31	1.19	1.07	1.01	0.92	0.87	0.81	0.75	0.70		
3	1.34	1.19	1.13	1.10	0.96	0.83	0.73	0.64			
7	1.07	1.00	0.84	0.74	0.66	0.61	0.57	0.54			
8	1.05	0.89	0.77	0.68	0.60	0.54	0.48	0.41			
11	1.14	1.11	1.01	0.91	0.83	0.77	0.72	0.66			
16	1.26	1.13	1.05	0.97	0.90	0.83	0.74				
17	1.13	1.08	1.04								
18	0.94										
19	1.21										
20	1.22	1.06	0.84	0.84	0.78	0.73	0.68	0.65			
25	1.27	1.16	1.06	0.97	0.91	0.85	0.80	0.75			
27	1.32	1.04	0.96	0.89	1.02	0.97	0.94				
Monthly means...	1.34	1.17	1.07	0.97	0.87	0.82	0.76	0.70	0.62		
Departure from 9-year normal...	-0.07	-0.02	-0.03	-0.05	-0.04	-0.03	-0.03	-0.05	-0.07		
P. M.											
Nov. 1	1.25	1.13	1.01	0.92	0.85	0.80	0.74	0.70			
2	1.20	1.11	1.00	0.91	0.83	0.76	0.70	0.65			
3	1.17	1.02	0.92	0.84	0.74	0.63	0.54	0.47			
7	0.90	0.77	0.66	0.57	0.50	0.45	0.40				
8	1.16	1.15	1.04	0.94	0.87	0.80					
10	1.32	1.21	1.11	1.01	0.92	0.85	0.79	0.74			
11	1.01	0.89	0.72	0.62	0.53	0.47	0.42	0.38			
16	1.24	1.13	1.03	0.95	0.89	0.83	0.82				
17			0.88	0.80	0.72	0.66	0.60	0.56			
21		1.16	1.07	0.99	0.91	0.82	0.73	0.66			
24		1.28	1.20	1.12	1.05	0.97	0.90	0.87			
25			1.14	1.07	1.01	0.94	0.89	0.85	0.80		
27			1.16	1.10	1.04	0.98	0.77	0.75	0.70		
Monthly means...		1.17	1.09	0.98	0.90	0.82	0.74	0.68	0.63		
Departure from 9-year normal...		-0.03	± 0.00	± 0.00	± 0.00	± 0.00	± 0.00	-0.03	-0.04	-0.04	

TABLE 1.—Solar radiation intensities during November, 1916—Con.

Madison, Wis.

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	
Air mass.											
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
A. M.	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	
Nov. 2	1.33	1.20									
4	1.28	1.22	1.14	1.09	1.02	0.95	0.92				
9	1.37	1.34	1.24	1.18	1.12	1.04	0.96	0.87			
14	1.36	1.24	1.15	1.03	0.93						
15	1.38	1.24	1.16	1.07	1.00	0.93					
18											
25											
29											
30											
Monthly means...	1.32	1.24	1.17	1.09	1.03	0.98	0.94	0.87			
Departure from 7-year normal...	+0.01	+0.03	+0.03	-0.07	± 0.00	± 0.00	± 0.00	+0.10			
P. M.											
Nov. 1	1.36	1.27	1.18								
4	1.28	1.26	1.19								
9											
14											
15											
16											
18											
29											
Monthly means...	1.32	1.27	1.20	1.12							
Departure from 7-year normal...	+0.01	+0.02	+0.10								
Lincoln, Nebr.											
A. M.	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	<i>Gr.-cal.</i>	
Nov. 1	1.40	1.32	1.27	1.15	1.05	1.03					
4	1.22	1.20	1.08	0.98	0.88	0.82	0.78				
6	1.38	1.13	1.07	0.98	0.91	0.85	0.81				
13	1.48	1.37	1.27								
14											
15		1.44	1.37	1.30	1.23	1.17	1.11				
16			1.24	1.21	1.15	1.07	1.00	0.93			
17				1.33							
24		1.49	1.39	1.33	1.26	1.21	1.17	1.13			
25		1.38	1.24	1.15	1.06	0.98	0.90				
29		1.45	1.39	1.33	1.26	1.17	1.13	1.07	1.00		
Monthly means...	1.38	1.33	1.26	1.17	1.09	1.04	0.99	0.92			
Departure from 2-year normal...	-0.02	-0.04	-0.02	-0.02	-0.02	-0.02	-0.01				
P. M.											
Nov. 1	1.35	1.26									
2	1.42	1.33	1.23	1.11	1.05	0.98	0.90				
4	1.22	1.14	1.01	0.92	0.85	0.79	0.72				
6	1.38	1.29	1.18	1.10	1.02	0.94	0.85				
13	1.48	1.44	1.34	1.27	1.20	1.14	1.08	1.04			
14		1.38	1.31	1.24	1.17	1.11	1.06				
17		1.51	1.40	1.32	1.25	1.17	1.12	1.07			
24		1.57	1.48	1.38	1.24	1.16	1.09	1.01	0.93		
25			1.41								
28		1.37	1.39	1.27	1.22	1.18	1.07	1.02	0.98		
29											
Monthly means...	1.41	1.35	1.26	1.17	1.10	1.03	0.96	0.90			
Departure from 2-year normal...	-0.02	± 0.00	+0.01	± 0.00	± 0.00	± 0.00	-0.01	-0.02	-0.02	-0.02	

TABLE 1.—*Solar radiation intensities during November, 1916—Con.*

Santa Fe, N. Mex.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
A. M.		<i>Gr.-cal.</i>		<i>Gr.-cal.</i>		<i>Gr.-cal.</i>		<i>Gr.-cal.</i>		<i>Gr.-cal.</i>
Nov. 1		1.56		1.50		1.45				
6										
10		1.55	1.53	1.47	1.39	1.32	1.20	1.27	1.22	
11			1.52		1.37				1.22	
14		1.63	1.58	1.52	1.44					
15			1.60	1.55	1.48	1.41				
17				1.42	1.38	1.31	1.22			
25				1.54	1.47					
28				1.50						
29					1.46	1.38	1.31	1.21	1.07	
Monthly means										
Departure from 5-year normal		+0.01	-0.04	±0.00	+0.03	+0.02	±0.00	±0.00	±0.00	
P. M.										
Nov. 1			1.48	1.38	1.30	1.26				
10			1.50	1.43	1.36	1.32	1.27	1.21		
14				1.48	1.41	1.36	1.29	1.22		
23				1.48	1.43	1.32				
28				1.50	1.41	1.34	1.21	1.14	1.08	
29					1.35	1.28				
Monthly means										
		1.49	1.44	1.35	1.27	1.23	1.17			

TABLE 2.—*Vapor pressure at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.	Date.	8 a.m.	8 p.m.
1916. Nov. 1	Mm. 5.16	Mm. 3.30	1916. Nov. 1	Mm. 3.81	Mm. 3.99	1916. Nov. 1	Mm. 3.63	Mm. 4.57	1916. Nov. 1	Mm. 3.45	Mm. 3.63
2	4.95	5.36	2	3.99	3.81	2	3.99	4.37	5	2.36	3.15
3	4.57	4.95	4	6.50	4.75	4	5.79	6.76	10	2.87	3.00
7	7.04	6.78	9	4.37	4.37	6	9.14	3.00	11	2.36	2.74
8	6.50	7.04	14	1.12	1.24	13	1.37	1.12	14	1.19	1.68
10	5.16	5.56	15	1.45	1.24	14	0.79	1.37	15	1.32	1.88
11	5.79	4.75	18	2.49	4.37	15	1.32	2.26	17	1.45	2.06
16	1.78	2.36	25	1.60	2.62	16	3.30	3.45	23	2.62	2.28
17	2.74	3.09	29	5.36	3.00	17	3.30	3.15	25	2.06	3.63
18	3.99	3.81	30	2.87	3.45	24	1.96	1.88	28	2.06	2.06
19	3.00	4.17				25	2.62	3.99	29	1.68	1.88
20	4.57	5.56				28	3.15	4.17			
21	3.00	3.63				29	3.15	3.63			
24	5.16	2.06									
25	1.60	1.96									
26	1.88	2.62									
27	3.30	3.63									

Table 3 shows about the normal amount of radiation for the month at Madison and deficiencies of 4 per cent and 5.5 per cent at Lincoln and Washington, respectively.

But few half-day series of direct solar radiation measurements at any of the stations indicate even approximately steady sky conditions. At Santa Fe this is principally due to the effect of city smoke. The best series obtained have been extrapolated to zero air mass; and from the values of  $Q_0$  thus obtained, in connection with

the vapor pressures of Table 2, the value of the solar constant has been computed by the Smithsonian abridged method. The results for the different stations, as shown by Table 4, are in good accord with each other and also with Abbot's mean value. Previous experience would lead us to expect this result during the cold part of the year, when the surface vapor pressure does not differ greatly from station to station.

TABLE 3.—*Daily totals and departures of solar and sky radiation during November, 1916.*

Day of month.	[Gram-calories per square centimeter of horizontal surface.]									
	Daily totals.			Departures from normal.			Excess or deficiency since first of month.			
	Wash- ington.	Madis- on.	Lin- coln.	Wash- ington.	Madis- on.	Lin- coln.	Wash- ington.	Madis- on.	Lin- coln.	
Nov. 1	347	297	315	87	86	49	87	86	49	49
2	314	290	294	57	92	31	144	178	80	80
3	328	120	245	74	—75	—15	218	103	65	65
4	110	280	277	—141	88	40	77	191	105	105
5	254	219	277	6	30	23	83	221	128	128
6	125	223	305	—121	35	53	—38	256	151	151
7	298	59	92	55	—125	—157	17	131	24	24
8	291	15	119	51	—166	—127	68	—35	—103	—103
9	288	265	246	50	87	3	118	52	—100	—100
10	287	143	152	52	—33	—88	170	19	—188	—188
11	263	73	60	31	—100	—178	201	81	—266	—266
12	55	12	63	—174	—158	—172	27	—239	—538	—538
13	81	85	330	—146	—82	98	119	—321	—440	—440
14	67	283	311	—157	119	82	276	—202	—358	—358
15	73	279	285	—148	118	59	424	—84	—299	—299
16	303	193	233	84	34	9	340	—50	—290	—290
17	274	159	280	58	2	59	282	—48	—231	—231
18	219	249	250	6	95	31	276	—47	—200	—200
19	269	234	259	58	82	43	218	128	—157	—157
20	226	87	244	18	—63	30	200	66	—127	—127
							370	47	61	
							Decade departure			
21	228	70	33	22	—78	—178	178	—12	—305	—305
22	161	41	49	—42	—105	—160	220	—117	—465	—465
23	34	64	152	—166	—80	—55	386	—197	—520	—520
24	242	160	272	44	18	68	342	—179	—452	—452
25	253	190	235	58	50	33	284	—129	—419	—419
26	240	173	239	47	34	39	237	—95	—380	—380
27	263	52	208	72	—86	10	185	—181	—370	—370
28	159	129	206	—30	8	10	195	—189	—360	—360
29	56	184	256	—131	48	62	326	—141	—298	—298
30	146	214	223	—39	79	31	365	—62	—267	—267
							165	—128	—140	—140
							Excess or deficiency (Gr.-cal.)	—5,896	+3,224	
							since first of year: (Per cent)	—4.7	+2.7	

TABLE 4.—*Solar radiation intensities for zenithal sun, reduced to mean solar distance of the earth, and approximate values of the solar constant.*

Station.	Date.	Radiation intensity.		Solar constant.
		m=1.	m=0.	
		Gr.-cal.	Gr.-cal.	
Lincoln, Nebr.	1916. Nov. 6, p. m..	1.61	1.83	1.94
	Nov. 13, p. m..	1.64	1.88	1.90
	Nov. 15, a. m..	1.65	1.82	1.89
	Nov. 24, a. m..	1.70	1.89	1.98
	Nov. 29, a. m..	1.60	1.78	1.89
Mean.				1.92
Washington, D. C.	Nov. 1, p. m..	1.52	1.83	1.94
Santa Fe, N. Mex.	Nov. 15, p. m..	1.67	1.84	1.92